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Introduction

Bibliometrics is an LIS research method. It is a quantitative study of the literature on a topic and is used to identify patterns of publication, authorship, and secondary journal coverage to get an insight into the growth of knowledge on that topic. This leads to better organization of information resources which, is essential for effective and efficient use. Bibliometrics has attained a sophistication and complexity, and has a national, international, and interdisciplinary character. The present study focuses attention on the bibliometric analysis publication in the area of ecology.

The term “Bibliometrics” was coined by Pritchard in 1969, and its practice can be traced back to the second decade of the 20 th century. A very early example of a bibliometric study was a “statistical analysis of the literature” of comparative anatomy from 1543 to 1860, which counted books and journal article titles, and grouped them by countries of origin within periods. In 1923, a study was conducted by Hulme on the history of science. His analysis was based on the seventeen sections of the *English International Catalogue of Scientific Literature*.

A third study was the pioneering work of Gross and Gross, reported in 1927. They counted and analyzed the citations in articles in the *Journal of the American Chemical Society,* and produced a list of significant journals in chemical education. Another prominent work was Bradford (1934) on the distribution of lubrication research. This research formed the backbone of the theoretical foundation of the bibliometric study, known as the “Bradford's Law of Scattering.”

Bibliometrics has been known by other names, including “statistical analysis of the literature” (Cole and Eales 1917), while Hulme used the term “statistical bibliography” in 1923.

In 1948, the great library scientist S.R. Ranganathan coined the term “librametry”, which referred to measurement used to streamline library services. “Bibliometrics” is analogous to Ranganathan's librametrics, the Russian concept scientometrics, FID's infometrics, and to some other well established sub-disciplines such as econometrics, psychometrics, sociometrics, biometrics, technometrics, chemometrics, and climetrics, where mathematics and statistics have been systematically applied to study and solve problems in a given field. The term “scientometrics” is currently used for the application of quantitative methods to the history of science, and obviously overlaps with bibliometrics to a considerable extent.

Bibliometric Laws

Bibliometric laws are statistical expressions that describe its mathematical basis. The three basic laws in bibliometrics are:

Lotka's Law. This is the earliest and most widely-applied study in measuring the scientific productivity of an author. Lotka claims that a large proportion of the literature is produced by a small number of authors and it is distributed so that the number of people producing ‘n' papers is approximately 1/n 2

Zipf's Law is a statistical distribution of word frequency on a hyperbolic curve, which states: “If the words are arranged in their decreasing order of frequency, then the rank of any given word of the text will be inversely proportional to the frequency of occurence of the word.”

Bradford 's Law is probably the best known bibliometric concept. It describes how the literature on a subject is distributed in journals. Bradford divides the articles found on a subject into three zones, which increase by a multiple of five. The relation between number of periodicals in the first zone and the successive zones is represented as 1:n:n 2.

Application of Bibliometrics

Bibliometrics has extensive application in identifying the research trends in a subject, trends in a authorship and collaboration in research, core periodicals, obsolescence and dispersion of scientific literature in estimating the comprehensiveness of secondary periodicals, author productivity and impact of research, distribution of scientific publications by universities, citation studies, and so on. Most of these studies pertain to universities, scientists, disciplines, and documents. Bibliometrics can also be used to identify emerging research areas.

The adoption of bibliometric techniques stimulated the growth of literature on bibliometrics and related areas. It has been found that a quarter of articles published in LIS periodicals have some sort of bibliometric approach. These techniques are being used for purposes like determination of various scientific indicators, evaluation of scientific output, selection of journals for libraries, and even forecasting potential Nobel Laureates.

In recent years, there has been an explosive growth in human knowledge. At the global level about 5 million articles are being published annually in about one lakh (100,000) journals. There has been a two hundred percent increase in the number of scientific periodicals since 1970. De Solla Price claimed that the science literature has grown exponentially in the last three centuries with a doubling rate of approximately 15 years.

The major focus of the study is to apply bibliometric analysis to analyse the performance of research output of scientists in the universities of Tamil Nadu. It examines the emergence of research areas, research groups, and research departments in universities to map the cognitive or intellectual structure of research.

Literature Review

There are various research studies highlighting the importance of bibliometric analysis and their application to library management and administration. This type of analysis enables the researcher to identify research gaps in previous studies.

Louttit (1957) analysed the language of research papers by psychologists, chemists, and physicists. More than 90 percent of references by writers in English language journals were in English, in German journals 91 percent German, in French journals 64.6 percent in French. Numerous studies in the social sciences show reference in American sources, with about 90 percent in English. Simonton (1960) examines two journals in fine arts, finding that more than half the references were to material in languages other than English.

Ozinonu (1970) made an early survey relating to the growth of basic science in Turkey. The author identifies the growth of human resources and the frequency of publications in mathematics, physics, astronomy, chemistry, and bio-science for the period 1933-1966.

Rangarajan and Poonam Bhatnagar (1981) analysed the bibliometric data compiled from *Physics Abstracts* on research papers published in the area of Mossbauer effect studies over a period of two decades from its discovery in respect of media choice.

Klaic (1990) examined the research activity of chemists from Rugjer Boskovic, Yugoslavia during 1976-1985, covering 2,018 papers, which were classified according to subfields used in *Journal Citation Reports.* He found that more than 67 percent of papers corresponded to journal articles.

Kannappanavar and Vijayakumar (2001) made a study on the authorship trends in International Monetary Fund Literature from 1991-1998 and concluded that collaborative research is increasing, varying from 0.45-0.62. The average degree of collaboration was found to be 0.56-0.81 by studying five journals in geology covering a period from 1987-1996.

Robert Dalpe (2002) conducted a study to assess quality in bibliometric studies in relation to collaboration of authors using biotechnology research and revealed the interaction between science and technology.

Garg (2003) gives an overview of the studies published in the international journal *Scientometrics* during 1978-2000 on cross-national, national, and institutional scientometric assessment.

Abbas Horri (2004) did a bibliometric overview of library and information science research productivity in Iran during 1996-1998. His findings indicate that most contributions to the field are research papers, theses, and research reports.

Methodology

The present study attempts to find the pattern of information published by scientific researchers on ecology in India. The study analyses the growth and development of publication output as reflected in *Web of Science* from 1990 to 2006. There are 501 records that were retrieved from *Web of Science*, an abstract and citation database of research literature and web sources.

Web of Science is an online resource that combines three databases: *Science Citation Abstracts (SCI) Expanded* (an SCI edition with broader coverage), the *Social Science Citation Index* (SSCI), and *Arts & Humanities Citation Index* (A&HCI). SCIE covers about 5,900 journals, SCI covers about 3,500, the SSCI 1,700 and 3,300 selectively, while the A&HCI covers more than 1,100 journals fully and about 7,000 selectively.

The publications of scientists are mostly in the form of journals, notes, letters, review, editorial-materials, meeting-abstracts, bibliographic-items and discussions. The research papers published by scientists in ecology covered in the annual version of *SCIE* were taken as the prime source for the present study. There were 501 papers by Indian scientists published from 1990 to 2006. The bibliographic

details of publications were recorded on index cards. The cards were arranged in different ways to identify the research performance of faculty members.

Analysis and Interpretation

The analysis of data from SCIE for 1990-2006 was done to measure the growth of literature. The literature was analysed to ascertain forms of publications, authorship patterns, authorship distribution, author productivity, productivity index to find transience, institution-wise performance, and distribution of articles in journals. The research output of ecology scientists in India, is used as a base to measure the above-mentioned parameters.

Table 1. Year-wise distribution of research on ecology in India

Publication Year	Research output	% of 501
1990	17	3.39
1991	19	3.79
1992	19	3.79
1993	24	4.79
1994	17	3.39
1995	17	3.39
1996	20	3.99
1997	20	3.99
1998	32	6.39
1999	21	4.19
2000	36	7.19
2001	33	6.59
2002	40	7.98
2003	39	7.78
2004	46	9.18
2005	54	10.98
2006	47	9.40
Total	501	100.00

The highest number of publications in the years being studied was 54 in 2005. The average number of publications per year was 29.47. The lowest number of publications was 17 in 1990, 1994, 1995.

Table 2. Authorship pattern of research on ecology in India

No. of Authors	No. of Contribution	Percentage	Cumulative Percentage
1	97	19.36	19.36
2	198	39.52	58.88
3	109	21.76	80.64
4	49	9.78	90.42
5	18	3.60	94.02
6	12	2.40	96.42
7	5	0.99	97.41
8	4	0.80	98.21
9	2	0.40	98.61
10 and above	7	1.39	100.00
Total	501	100.00	

Table 2 clearly shows the authorship pattern. Nearly two-fifths of the papers have two authors. Papers with three authors account for slightly more than one-fifth. Another fifth have single authors.

Table 3. Ranking of authors

Author	Publication	of 501
SINGH,JS	15	2.99
INDERJIT	11	2.20
SUKUMAR,R	9	1.80
ANIL,AC	7	1.40
ANSARI,ZA	7	1.40
GADGIL,M	7	1.40
CHATTOPADHYAY,J	6	1.20
DAKSHINI,KMM	6	1.20
RAJU,AJS	6	1.20
RAO,SP	6	1.20
SARKAR,RR	6	1.20
PARULEKAR,AH	5	1.00
REDDI,CS	5	1.00
SHARMA,BK	5	1.00
ANANTHAKRISHNAN, TN	4	0.80
ATLURI,JB	4	0.80
CHOWDHURY,D	4	0.80
JOSHI,A	4	0.80
KHAN,MA	4	0.80
KHURANA,E	4	0.80
KUMAR,A	4	0.80

MUKHERJEE,PK	4	0.80
RAGHYKUMAR,S	4	0.80
SHANKER,K	4	0.80
SHANOWER,TG	4	0.80
SINGH,SP	4	0.80
SRIDHAR,KR	4	0.80
STAUFFER,D	4	0.80
WATVE,MG	4	0.80
AKHTAR,N	3	0.60
BARGALI,HS	3	0.60
BRAHMACHARY,RL	3	0.60
CHAUDHURI,PK	3	0.60
CHAUHAN,NPS	3	0.60
DANIELS,RJR	3	0.60
DAS,S	3	0.60
GADAGKAR,R	3	0.60
GOWER,DJ	3	0.60
GOYAL,SP	3	0.60
GUPTA, AK	3	0.60
HAZRA,N	3	0.60
INGOLE,BS	3	0.60
JOSEPH,A	3	0.60
MADHUSUDAN, MD	3	0.60
MANDAL,S	3	0.60
MEASEY,GJ	3	0.60
OMKAR	3	0.60
OOMMEN,OV	3	0.60
PAL,SK	3	0.60
PANIGRAHY,RC	3	0.60
PERVEZ,A	3	0.60
RADDER,RS	3	0.60
RAGHUBANSHI,AS	3	0.60
ROMEIS,J	3	0.60
ROY,PS	3	0.60
SAGAR,R	3	0.60
SAIDAPUR, SK	3	0.60
SHANBHAG,BA	3	0.60
SHARMA,S	3	0.60
SIHAG,RC	3	0.60
SINGH,M	3	0.60
SINHA,A	3	0.60

SUNDARAMOORTHY,S	3	0.60
VENKAT,K	3	0.60
VENUGOPALAN,VP	3	0.60
VERGHESE,T	3	0.60
WILKINSON,M	3	0.60
105 Authors 2 Articles	105	0.40
860 Authors single Article	860	0.20
Total		100.00

An attempt has been made to analyze the research performance of individual scientists in ecology. The contributions of individual scientists varies. The highest number of papers is 15 by J.S. Singh.

Table 4. Collaborative country-wise distribution of research output

Country / Territory	Record Count	of 501
INDIA	501	100.00
USA	40	7.98
ENGLAND	15	2.99
GERMANY	11	2.20
CANADA	9	1.80
FRANCE	6	1.20
JAPAN	4	0.80
NETHERLANDS	4	0.80
SCOTLAND	4	0.80
PHILIPPINES	3	0.60
SWEDEN	3	0.60
DENMARK	2	0.40
ITALY	2	0.40
MALAWI	2	0.40
PANAMA	2	0.40
SPAIN	2	0.40
AUSTRALIA	2	0.40
AUSTRIA	1	0.20
BANGLADESH	1	0.20
BELGIUM	1	0.20
BRAZIL	1	0.20
HONG KONG	1	0.20
ISRAEL	1	0.20
KENYA	1	0.20
KUWAIT	1	0.20
MALAYSIA	1	0.20

MOROCCO	1	0.20
NEW ZEALAND	1	0.20
NIGERIA	1	0.20
NORWAY	1	0.20
CHINA	1	0.20
SINGAPORE	1	0.20
SOUTH KOREA	1	0.20
SWITZERLAND	1	0.20
TAIWAN	1	0.20
THAILAND	1	0.20
WALES	1	0.20

Authors of the 501 ecology papers collaborated with scientists from a number of countries, including the USA, UK, Germany, Canada, France, Japan, Netherlands, Scotland, Philippines, Sweden, Denmark, and Italy.

Table 5. Source-wise distribution of ecology research output

Source	Output	% of 501
ARTICLE	430	86.83
REVIEW	51	10.20
NOTE	9	1.80
EDITORIAL MATERIAL	5	1.00
LETTER	4	0.80
BOOK REVIEW	1	0.20
NEWS ITEM	1	0.20
Total	501	100.00

More than 86 percent of the 501 publications were journal articles.

Table 6. Single vs. multiple-authored output on ecology

Authors	Output	%
Single Author	97	19.36
Multiple Author	404	80.64
Total	501	100

More than 80 percent of the publications have two or more authors.

Table 7. Language-wise distribution of research output on ecology

Sl. No.	Language	Records	%
1	English	499	99.60
2	French	2	0.40
	Total	501	100.00

Only one publication of the 501 is in a language other than English.

Findings

The present study has been undertaken to assess the research performance of Indian scientists in ecology. The results of research have been published in different sources. The findings of the present study lead to the following observations:

- The largest number of publications was 54 in 2005.
- The largest portion (nearly 40 percent) have two authors.
- J.S. Singh captured first place among authors, with 15 publications during the study period.
- Researchers have good relationships with various countries, including the USA, US, Germany, etc.
- Journal articles occupy the predominant place among sources of publication.
- More than 80 percent of the publications have two or more authors.

Suggestions

The findings of the present study lead to the following recommendations:

- More infrastructural facilities should be provided to ecology research institutions and academic institutions as well.
- Special training programmes are needed help scientists pursue research activities on par with world output.
- There is a need for incentives and awards to eminent and outstanding scientists according to their contribution to the growth of research and development of the discipline.
- There is a need to encourage collaborative research activities, so that ecologists are encouraged to do collaborative research with researchers in other countries.
- Scientists should be given more projects in the subject fields which lag behind.
- Funding agencies should allocate an equal number of projects to all institutions.
- The state and central governments should allocate more funds for research activities for all institutions.

Conclusion

Research trend in ecology is collaborative in nature like any other discipline. Bibliometric studies are concentrated on data drawn from databases, individual journals, individual institutions, research output in a particular field of knowledge, individual subject output, individual author publications, and so on.

References

British Standards Institution. *British Standards Documentation Terms.* London: BSI, 1976.

Clark, C.V. “Obsolescence of the Patent Literature.” *Journal of Documentation* 32.1(1976):32-52

De Solla Price D.J. *Little Science, Big Science.* New York: Columbia University, 1934.

Hawkins, D.T. “Unconventional uses of Online Information Retrieval Systems: Online Bibliometric Studies.” *Journal of American Society of Information Science* 28.1 (1977):13-18

Jain, A., K.C. Garg. “Laser Research in India: Scientometric Study and Model Projection.” *Scientometrics* 23 (1992):395-415

Kundra, R. “Investigation of Collaborative Research Trends in Indian Medical Sciences 1900-1945.” *Scientometrics* 36(1996):69-80.

Morales, M. “Information and its Importance.” *International Forum for Information and Documentation* 10 (1985):15-21.

Nagpaul, P.S.L. “Research Output and Transnational Cooperation in Physics Subfields: A Multi-dimensional Analysis.” *Scientometrics* 31 (1994):97-122.

Nicholas, D., and Ritchie, M. *Literature on Bibliometrics.* London: Bingley,1968.

Potter,W.G. “Introduction to Bibliometrics.” *Library Trends* 30 (1981):5-7.

Ranganathan, S.R. “Library and its Scope.” *DRTC Annual Seminar* 702 (1969):285-301

Schrader, Alvin M. “Teaching Bibliometrics.” *Library Trends* 30 (1981) 151-172.

White, Emile C. “Bibliometrics: From Curiosity to Convention.” *Special Libraries* (1985) 35-42.